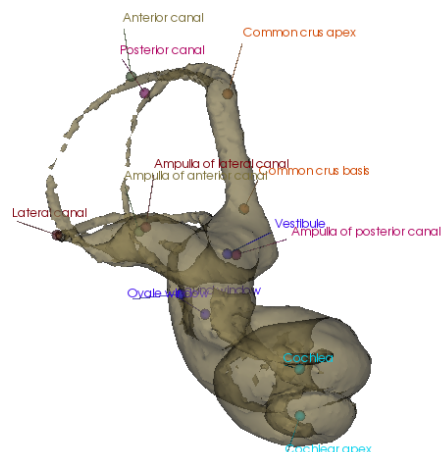




MorphoDig

Tutorial 04: working with flags



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Tutorial 04 includes:

- One .ntw (MorphoDig project) file
- One .vtk surface file representing a right inner ear of *Mus musculus*
- One .pos (position) file
- One .ori (orientation helper labels) file
- The present .pdf document

4.1 About the specimen

The surface file enclosed in this tutorial represent three-dimensional reconstruction of the right inner ear of a house mouse (*Mus musculus*) obtained by computerized microtomography at the MRI μ CT platform housed at the ISEM.




Before using this tutorial, please download and read MorphoDig User Guide.

4.2 A brief overview of enclosed files

Download and unzip the files associated to this tutorial. Open MorphoDig.

4.2.1 Mouse inner ear surface and position files

You may open the enclosed .vtk surface file (File -> Surface -> Open Surface, then select "Mouse_right_ear.vtk", or drag and drop this file in the 3D main window). When opened this way, the corresponding opened surface object is drawn grey, which indicates that this surface is selected. You may interact with selected objects in different ways (see MorphoDig user guide for further explanations).

By default () , the camera rotates around the center of mass of all opened objects. This behavior is useful when the center of mass of an object (or of several ones) is far from the origin of the coordinate system. But by pressing the camera button ( -> ) , the camera will revolve around the center of the coordinate system (x=0, y=0, z=0). The display grid is drawn using different colors depending on the camera rotation center (see Fig. 4.1 p.4).

As a general rule, when opening a new surface, it is strongly advised to change its position in order that it matches the 6 predefined camera positions :



view object from right side



view object from left side



view object from front side (default camera position)






view object from back side





view object from above




view object from below

In "object interaction mode()", selected objects can be translated and rotated using the mouse left and middle buttons (in landmark  and camera  selection modes, you also need to maintain "CTRL" button pressed while dragging the left mouse button to achieve rotation and translation of selected objects). Alternatively, you may also use the "yellow sliders" located on the right side of the 3D main window to accomplish rotation and translation of selected objects. Rotation is achieved around the global center of mass of all currently selected objects.

A convenient way to orient a right inner ear in a biologically relevant way is done as follows (see Fig. 4.2 p.5):

- 1) place camera to view object from the front side ()
- 2) place the lateral semi-circular canal in the horizontal plane (x-y plane)
- 3) place camera to view object from above ()
- 4) rotate the inner around the z axis ("rz" yellow slider) until the later semicircular points towards the top left-hand part of the screen, and the cochlea points towards the bottom right-hand of the screen.

That way, when viewing the inner ear from the front side () , it is approximately oriented in

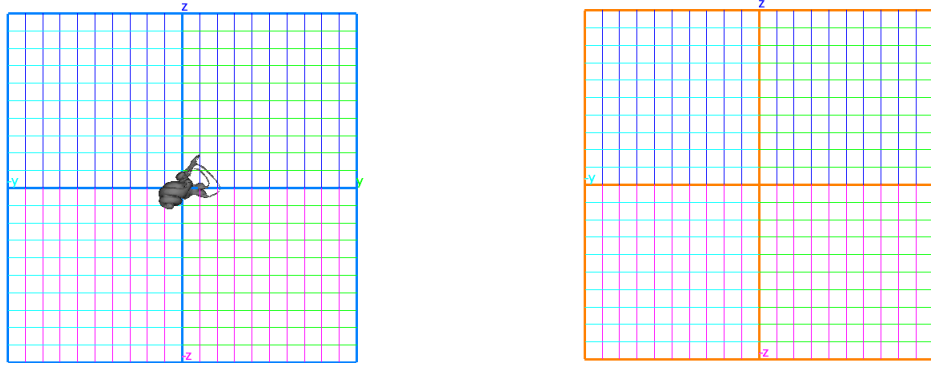


Figure 4.1: Grid display color. Left: when the camera revolves around the center of mass of all opened objects, the grid has a blue outline. Right: when the camera revolves around the origin of the coordinate system ($x=0$, $y=0$, $z=0$), the grid outline is displayed in orange.

the same way as it would be within the cranium viewed from the front side as well.

The present tutorial contains a .pos (position) file, which you may open in order to place correctly the right ear of the house mouse (File -> Position-> Open Position for selected surfaces, then choose "Mouse_right_ear.pos", see Fig. 4.2 p.5). As we plan to place curve node landmarks and curve handle landmarks inside the cochlea and the semicircular canals, please select the right inner ear surface (CTRL+A, or drag right mouse button to draw a selection rectangle) and change its transparency (Edit Selected Surface->rendering modifications->Change transparency -> then give a value smaller than 100).

All opened surfaces can be unselected by pressing "CTRL +D", or selected by pressing "CTRL +A". All selected objects can be deleted by pressing "Del".

4.2.2 Mouse inner ear project file

The present tutorial contains a project .ntw file, which may be useful to directly open the right inner ear in a convenient position, to make it transparent and to give it a color. First, delete all currently opened objects (press "CTRL+A", then press "Del"). Then open the enclosed .ntw file (File -> Open Project, then select "Mouse_right_ear.ntw"). Once loaded, the right inner ear surface is opened, is given the position enclosed in the "Mouse_right_ear.pos" file, a color and a transparency. Note that the newly opened surface is unselected.

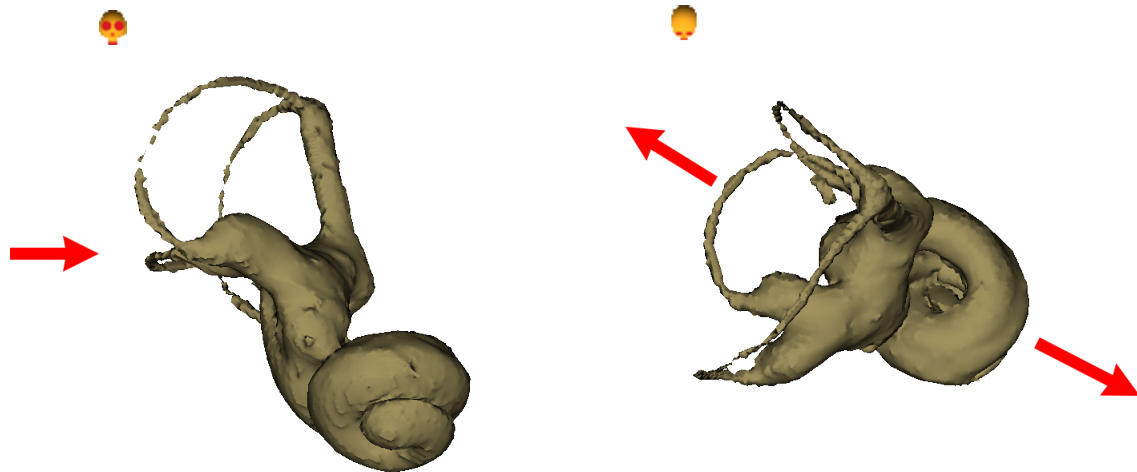


Figure 4.2: A convenient way to orientate right inner ears. Left: when viewed from the front side, the lateral canal is placed horizontally. Right: when viewed from above, the cochlea points towards the bottom right-hand of the screen, and the lateral canal towards the top left-hand of the screen.

4.2.3 Mouse inner ear flag file

Prerequisite : make sure that the mouse right inner ear surface is loaded, and that it is correctly positioned. You can load the enclosed .flag file (File->Flags->Open Flags-> Mouse_right_ear.flag or drag and drop this file directly in the 3D main window), which contains 13 flags.

4.2.4 Mouse inner ear .ori file

The present tutorial contains a .ori file, which contains orientation labels for the coordinate system orientation helper. You can load this file the enclosed .ori file ("File->Orientation helper labels -> Open Orientation labels", then select "Mouse_cranium.ori"). Once loaded, the system coordinate orientation helper will show the following labels :

+z axis : superior

-z axis : inferior

+y axis : medial

-y axis : lateral

+x axis : proximal

-x axis : distal

You may set your own orientation axis labels with the "Edit orientation labels" window (Edit-> Edit orientation labels)

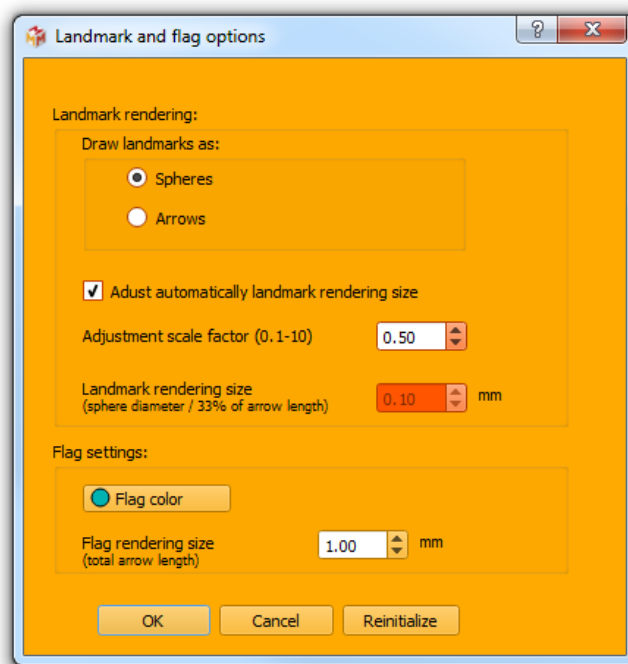



Figure 4.3: Landmark and flag options window.

4.3 Flag digitization with MorphoDig

4.3.1 Flag rendering options

Flags are rendered in MorphoDig the following way: a sphere is placed at the location of interest and rendered; additionally, a thin cylinder of a defined length is drawn between this location and the place where the label is rendered. conventional landmark location (do not try to select / unselect the label or the line directly, this will have no effect). You can change the way flags are rendered in the "Landmark and flag options" window (Edit->Edit landmark and flag rendering options, Fig. 4.3 p.6). You can choose the default flag length and the default flag color. As the structure we investigate in this tutorial is quite small (around 4 mm long), I recommend you to set the flag length to about 0.5mm.

4.3.2 Creating new flags

Press “” to activate flag digitization mode (this mode is **NOT** active by default)

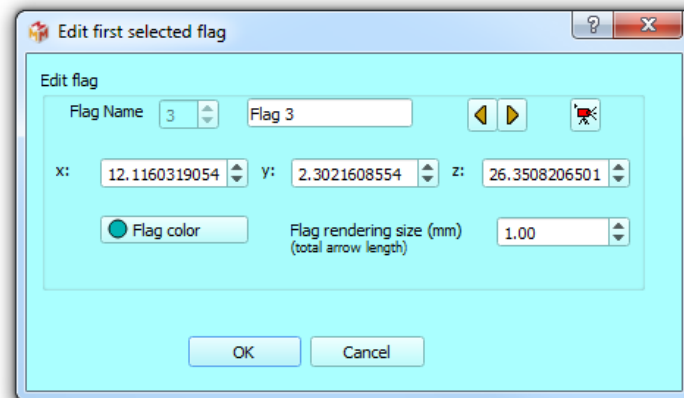







Figure 4.4: Edit first selected flag window.

4.3.3 Interacting with flags

When digitizing flag landmarks, I recommend to press " " to activate the "Landmark mode". When active, only landmarks (among which flag landmarks) can be selected/unselected via right mouse button drag/click. Flag landmarks can be set on surfaces by pressing "L" + left mouse click. If a single flag landmark is selected, its position can be moved on another part of the surface by pressing "L" + right mouse click (nothing happens if no flag is selected or if more than one flag are selected). Also, you may need to move flags away from the object's surface (for instance when you want to place a flag at the center of a foramen): once selected, the position of a given flag can be moved by using the usual mouse (CTRL + middle click + mouse drag) and GUI controls.

Flag landmark selection / unselection is performed as for other 3D objects:

- **Selecting flags 1 by 1:** press "CTRL +D" to unselect all 3D objects and click on " ^{Flag}  " : this button opens the "Edit first selected flag" window (see Fig. 4.4 p.7). Then click on  and  to navigate through all existing flags and to select them 1 by 1. That way, you can edit the properties of each of them individually.
- **Selecting flags with the mouse:** maintaining the right mouse button pressed while dragging the mouse will draw a selection rectangle. Once the right mouse button has been released, all unselected flags laying underneath the selection rectangle will be selected (and all selected surfaces will be unselected).
- **Selecting all flags (and all other 3D objects):**
all opened flags (+ all other objects) can be selected by pressing "CTRL +A" (conversely, all flags (+ all other objects) can be unselected by pressing "CTRL +D")

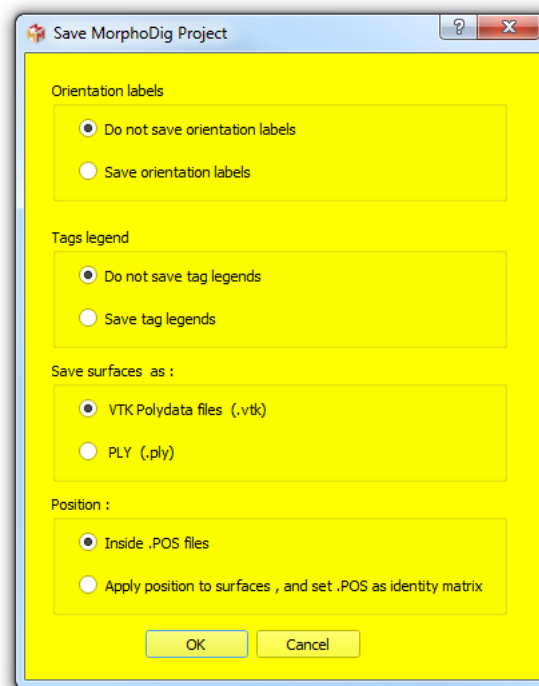


Figure 4.5: Save project window.

4.3.4 Saving flags

To save all digitized landmarks, go in "File->Flags->Save Flags".

4.3.5 Saving the project

Saving a "project" makes it possible to save all opened selected objects (surface of the inner ear and its position+color, flags) altogether instead of one by one. To save all opened objects, do the following sequence of actions:

- 1) press "CTRL + A" to select all objects
- 2) click on "File->Project->Save Project" or on the button "save project" (📁) inside the main window.
- 3) choose the desired options in the "Save Project" window (see Fig. 4.5 p.8 and the User Guide for further details regarding the available options)

The advantage of working with projects is that all involved objects (surfaces, flags, positions and colors) can be reloaded later all at once (and not 1 by 1).

4.4 Acknowledgements

Thanks to the MRI imaging platform for the access to imaging facilities.